INFORMATION ITEM

Lead Scientist's Report

Summary: Delta Lead Scientist Dr. Laurel Larsen will discuss a study by *Thompson et al.* (2020). The study analyzed the life history characteristics of different types of salmon and their implications for salmonid management. Dr. Larsen will also highlight upcoming events such as the Adaptive Management Forum, Steelhead Trout Workshop, and the 11th Biennial Bay-Delta Science Conference.

A COMPLEX PHENOTYPE IN SALMON CONTROLLED BY A SIMPLE CHANGE IN MIGRATORY TIMING. SCIENCE. OCTOBER. 2020.

This month's spotlighted article challenges scientific assumptions underlying the management of Chinook salmon in the Delta and elsewhere. Currently, different management strategies govern the different "ecotypes" of Chinook salmon, or collections of individuals that have distinct behaviors with respect to migration timing, as well as distinct physical characteristics such as fat content. Ecotypes that migrate early in the year are termed winter- and spring-run, whereas late-migrating ecotypes are termed fall- and late-fall-run. Importantly, the rarer spring-run Chinook salmon are protected under the Endangered Species Act, whereas fall-run salmon are not. Underlying this differentiation is the assumption that the spring- and fall-run salmon do not interbreed and essentially function as different species, with deep genetic differences. It is this assumption that the study calls into question.

Differences in species' physical characteristics or behavior often serve as the basis for categorization by scientists and resource managers. However, these physical differences may be entirely environmental or arise because of substantial genetic differences. The team leading this study investigated the question, "Are ecotypes of Chinook salmon actually biologically distinct species?". Implied in this study is the question, "Does it make sense to manage them accordingly?"

To address this question, the team evaluated the role of genetic variation in salmon ecotypes of the Klamath and Sacramento River basins, the latter of which harbors the greatest known diversity in run types. The whole genomes of 160 fish from all Chinook ecotypes in the Klamath and Sacramento Rivers were analyzed for comparative differences in their genetic structure.

Differences between fall- and spring-run Chinook were found in a small, single region of the salmon's DNA (termed the Region of Strong Association, or RoSA), with

a simple inheritance pattern analogous to eye color. In other words, if a fish inherited copies of the "early run" gene from each parent, it would also exhibit the early-run migration pattern. In contrast, individuals with "late run" genes from each parent would exhibit the late run pattern. Individuals who inherit one copy of the "late run" gene and one of the "early run" gene would exhibit intermediate timing for their migration. Indeed, the investigators found evidence of interbreeding of Chinook from different ecotypes. Further, they found that the RoSA almost perfectly predicted spawn migration timing of Chinook but not weight changes or sexual maturity—traits long believed to be central to salmon ecotypes. Rather, those traits arose as a product of the environments that individuals occupied and the timing of that occupation. Thus, they argued that ecotypes can still be considered to be the same species.

The findings that migratory ecotypes result from a single gene region (the RoSA), and is conserved across Chinook lineages, are positive developments for conservation and restoration of this ecologically, culturally, and economically important fish. Resource managers have long worried that the widespread loss of early-migrating Chinook implied irreversible loss of the genetic diversity associated with this ecotype. In contrast, this study suggests that the genes controlling local adaptations to host watersheds—found outside of the RoSA—remain present in populations. Thus, when ancestral watersheds are reopened (e.g., through the removal of dams on the Klamath River), the reestablishment of early-run populations adapted to these environments is likely and can be facilitated through management interventions. Such interventions include relocating individuals with the early-run genetic signature to those watersheds or hatchery operations to supplement nascent populations of early-run individuals and facilitate breeding. These findings highlight the importance of maintaining migratory opportunities and viable early-migrating source populations for recolonization.

For the Delta, this study calls into question the current management of the Chinook salmon ecotypes as different species. However, interpretation of the study's findings remain controversial within the scientific community. The anticipated continued discussion within the scientific literature will likely further illuminate conservation and management practices. Due to the implications for management, this study most exemplifies Chapter 4 of the Delta Plan, which focuses on the protection, restoration, and enhancement of the Delta ecosystem. Chapter 4 specifically speaks of improving hatchery and harvest management, and the findings have strong implications for effective management.

DELTA SCIENCE PROPOSAL SOLICITATION

On November 9, 2020, the Council's Delta Science Program, in coordination with the U.S. Bureau of Reclamation (Reclamation) and California Sea Grant, announced a solicitation for scientific research proposals in the Delta. The solicitation seeks to fund 12- to 31-month projects that directly inform management and advance the jointly-developed 2017-2021 Science Action Agenda. The total award amount is expected to be up to $9 million (up to $5.5 million from the Council and up to $3.5 million from Reclamation). Extensive outreach has been conducted by Council staff to raise awareness of this opportunity to researchers within and beyond the Delta. Letters of intent were due December 15, 2020. Over 130 letters of intent were received, requesting over $78 million in funding, nearly double that from the 2019 solicitation and over eight times available funding. Lead principal investigators were distributed across multiple states and even internationally. The Delta Science Program is presently assembling peer-review panels of relevant experts in anticipation of receipt of the full proposals.

Full proposals are due February 12, 2021**.** California Sea Grant and the Delta Science Program hosted virtual public information webinars on December 2, 2020, and January 8, 2021, to answer questions about the application process. For more details about the solicitation, including a new frequently asked questions document, please visit https://deltacouncil.ca.gov/delta-science-program/delta-science-proposal-solicitations.

ON YOUR RADAR

Adaptive Management Forum

Registration is now open for the 2021 Adaptive Management Forum, which will be held virtually **February 3-5, 2021**. Hosted biennially by the Delta Science Program, this forum provides an opportunity for the Delta community to share knowledge and promote collaboration around adaptive management of the Bay-Delta system. The 2021 forum will feature morning sessions with presentations by invited speakers, followed by Q&A and breakout discussions. Afternoon workshops will provide opportunities for participants to interact, network, and learn about specific adaptive management tools and practices. For more details, view the 2021 forum agenda.

Registration closes on January 28, 2021. For questions, contact Chelsea Batavia at adaptivemanagement@deltacouncil.ca.gov.

Steelhead Trout Workshop

The 2021 California Central Valley Steelhead Workshop will be held over three half-days, **February 16-18, 2021**. The workshop represents a collaborative effort between the Council, Reclamation, National Oceanic and Atmospheric Administration, Metropolitan Water District, California Department of Water Resources, and the U.S. Fish and Wildlife Service. As part of the Biological Opinion on the Long-Term Operation of the Central Valley Project and the State Water Project-3.6.2, Reclamation is required to coordinate with the Collaborative Science and Adaptive Management Program in the sponsorship of a workshop to develop a plan to monitor steelhead populations within the San Joaquin Basin and/or the San Joaquin River downstream of the confluence of the Stanislaus River. The Delta Science Program was asked to facilitate this workshop. This includes steelhead and rainbow trout on non-project San Joaquin tributaries. To register for the workshop, visit the Events tab on the Delta Stewardship Council webpage. Please direct any questions to Pascale Goertler at pascale.goertler@deltacouncil.ca.gov.

11th Biennial Bay-Delta Science Conference

The Bay-Delta Science Conference is a forum for sharing scientific information relevant to managing the connected San Francisco Bay and Sacramento-San Joaquin Delta systems. The conference will be held virtually **April 6-9, 2021**, and is jointly sponsored by the Council and the U.S. Geological Survey. This year's conference theme is Building Resilience through Diversity in Science. Participants include, but are not limited to, natural scientists, engineers, resource managers, and stakeholders working on Bay-Delta issues. Abstract submissions closed on December 28, 2020, with over 300 abstracts received.

To learn more about the conference, visit https://deltacouncil.ca.gov/delta-science-program/11th-biennial-bay-delta-science-conference.

BY THE NUMBERS

Delta Science Program staff will provide a summary of current numbers related to Delta water and environmental management. The summary **(Attachment 1)** will inform the Council of recent counts, measurements, and monitoring figures driving water and environmental management issues.

LIST OF ATTACHMENTS

Attachment 1: By the Numbers Summary

Attachment 2: Visual Abstract of Article Summary 1

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